

CLAIMS

What is claimed is:

1. A magnetoelectronics information device, comprising:

a free magnetic region;

a pinned magnetic region; and

a tunneling barrier interposed between said free magnetic region and said pinned magnetic region,

wherein magnetic moments of said free magnetic region and said pinned magnetic region that are adjacent to said tunneling barrier are oriented to provide a first magnetization state when:

a first magnetic field with a first field magnitude is produced in proximity to the magnetoelectronics information device at a first time ( $t_1$ );

a second magnetic field with a second field magnitude is produced in proximity to the magnetoelectronics information device at a second time ( $t_2$ );

said first magnetic field is adjusted to provide a third field magnitude that is less than said first field magnitude and greater than zero at a third time ( $t_3$ ); and

said second magnetic field is adjusted to provide a fourth field magnitude that is less than said second field magnitude at a fourth time ( $t_4$ ).

2. The magnetoelectronics information device of Claim 1, wherein  $t_1 < t_2 < t_3 < t_4$ .

3. The magnetoelectronics information device of Claim 2, wherein said first magnetic field is adjusted to provide a fifth field magnitude that is less than said third field magnitude at a fifth time ( $t_5$ ) that is greater than said fourth time ( $t_4$ ).

4. The magnetoelectronics information device of Claim 3, wherein said fifth field magnitude is approximately zero.

5. The magnetoelectronics information device of Claim 1, wherein said magnetic moment of said free magnetic region is preferably unbalanced.

6. The magnetoelectronics information device of Claim 5, wherein shall mean that the fractional balance ratio ( $M_{br}$ ) is in the range of about five hundredths (0.05) to about one tenth (0.1).

7. The magnetoelectronics information device of Claim 1, wherein said magnetic moments of said free magnetic region and said pinned magnetic region that are adjacent to said tunneling barrier are oriented to provide a second magnetization state when:

a third magnetic field with a fifth field magnitude is produced in proximity to the magnetoelectronics information device at a fifth time ( $t_5$ );

a fourth magnetic field with said sixth field magnitude is produced in proximity to the magnetoelectronics information device at a sixth time ( $t_6$ );

said third magnetic field is adjusted to provide a seventh field magnitude that is less than said fifth magnitude at a seventh time ( $t_7$ ); and

said fourth magnetic field is adjusted to provide an eighth field magnitude that is less than said sixth magnitude at an eighth time ( $t_8$ ).

8. The magnetoelectronics information device of Claim 7, wherein  $t_4 < t_5 < t_6 < t_7 < t_8$ .

9. The magnetoelectronics information device of Claim 7, wherein  $t_4 < t_6 < t_5 < t_8 < t_7$ .

10. The magnetoelectronics information device of Claim 1, wherein said magnetic moments of said free magnetic region and said pinned magnetic region that are adjacent to said tunneling barrier are oriented to provide a second magnetization state when:

a third magnetic field with a fifth field magnitude is produced in proximity to the magnetoelectronics information device at a fifth time ( $t_5$ );

a fourth magnetic field with said sixth field magnitude is produced in proximity to the magnetoelectronics information device at a sixth time ( $t_6$ );

said third magnetic field is adjusted to provide a seventh field magnitude that is less than said fifth magnitude at a seventh time ( $t_7$ );

said fourth magnetic field is adjusted to provide an eighth field magnitude that is less than said sixth magnitude and greater than zero at an eighth time ( $t_8$ ); and

said fourth magnetic field is adjusted to provide a ninth field magnitude that is less than said eighth field magnitude at a ninth time ( $t_9$ ).

11. The magnetoelectronics information device of Claim 10, wherein  $t_4 < t_5 < t_6 < t_7 < t_8 < t_9$ .

12. The magnetoelectronics information device of Claim 10, wherein said ninth field magnitude is approximately zero.

13. The magnetoelectronics information device of Claim 1, wherein said free magnetic region comprises:

a first ferromagnetic layer;

a second ferromagnetic layer; and

a non-magnetic layer interposed between said first ferromagnetic layer and said second ferromagnetic layer.

14. The magnetoelectronics information device of Claim 13, wherein said first ferromagnetic layer is at least partially formed of one material selected from the group comprising nickel (Ni), iron (Fe), or cobalt (Co).

15. The magnetoelectronics information device of Claim 14, wherein said second ferromagnetic layer is at least partially formed of one material selected from the group comprising nickel (Ni), iron (Fe), or cobalt (Co).

16. The magnetoelectronics information device of Claim 1, wherein said non-magnetic layer is at least partially formed of one material selected from the group ruthenium (Ru), osmium (Os), rhenium (Re), chromium (Cr), rhodium (Rh), or copper (Cu).

17. The magnetoelectronics information device of Claim 1, wherein said pinned magnetic region comprises an anti-ferromagnetic layer adjacent to a ferromagnetic layer.

18. The magnetoelectronics information device of Claim 17, wherein said anti-ferromagnetic layer is at least partially formed of one material selected from the group comprising iridium manganese iridium manganese (IrMn), iron manganese (FeMn), rhodium manganese (RhMn), platinum manganese (PtMn), and platinum palladium manganese (PtPdMn)

19. The magnetoelectronics information device of Claim 1, wherein said magnetoelectronics information device is an MRAM element.

20. The magnetoelectronics information device of Claim 1, wherein said third field magnitude is less than about seventy-five percent (75%) of the first field magnitude and greater than about twenty five percent (25%) of the first field magnitude.

21. The magnetoelectronics information device of Claim 1, wherein said third field magnitude is about fifty percent (50%) of the first field magnitude.

22. In a magnetoelectronics information device having a free magnetic region, a pinned magnetic region and a tunneling barrier interposed between said free magnetic region and said pinned magnetic region, a method for writing the magnetoelectronics information device comprising the steps of:

producing a first magnetic field with a first field magnitude in proximity to the magnetoelectronics information device at a first time ( $t_1$ );

producing a second magnetic field with a second field magnitude in produced in proximity to the magnetoelectronics information device at a second time ( $t_2$ );

adjusting said first magnetic field to provide a third field magnitude at a third time ( $t_3$ ) that is less than said first field magnitude and greater than zero; and

adjusting said second magnetic field to provide a fourth field magnitude at a fourth time ( $t_4$ ) that is less than said second magnitude.

23. The method for writing the magnetoelectronics information device of Claim 22, wherein  $t_1 < t_2 < t_3 < t_4$ .

24. The method for writing the magnetoelectronics information device of Claim 23, further comprising the step of adjusting said first magnetic field to provide a fifth field magnitude that is less than said third field magnitude at a fifth time ( $t_5$ ) that is greater than said fourth time ( $t_4$ ).

25. The method for writing the magnetoelectronics information device of Claim 24, wherein said fifth magnitude is approximately zero.

26. The method for writing the magnetoelectronics information device of Claim 22, further comprising the steps of:

adjusting a third magnetic field to provide a fifth field magnitude in proximity to the magnetoelectronics information device at a fifth time ( $t_5$ );

adjusting a fourth magnetic field to provide a sixth field magnitude in proximity to the magnetoelectronics information device at a sixth time ( $t_6$ );

adjusting said third magnetic field to provide a seventh field magnitude that is less than said fifth field magnitude at a seventh time ( $t_7$ ); and

adjusting said fourth magnetic field to provide an eighth field magnitude that is less than said sixth field magnitude at an eighth time ( $t_8$ ).

27. The method for writing the magnetoelectronics information device of Claim 26, wherein  $t_4 < t_5 < t_6 < t_7 < t_8$ .

28. The method for writing the magnetoelectronics information device of Claim 26, wherein  $t_4 < t_6 < t_5 < t_8 < t_7$ .

29. The method for writing the magnetoelectronics information device of Claim 22, further comprising the steps of:

adjusting a third magnetic field to provide a fifth field magnitude in proximity to the magnetoelectronics information device at a fifth time ( $t_5$ );

adjusting a fourth magnetic field to provide a sixth field magnitude in proximity to the magnetoelectronics information device at a sixth time at a sixth time ( $t_6$ );

adjusting said third magnetic field to provide a seventh field magnetic field that is less than said fifth field magnitude at a seventh time ( $t_7$ );

adjusting said fourth magnetic field to provide an eighth field magnitude that is less than said sixth field magnitude and greater than zero at an time ( $t_8$ ); and

adjusting said fourth magnetic field to provide a ninth field magnitude that is less than said eighth field magnitude at a ninth time ( $t_9$ ).

30. The magnetoelectronics information device of Claim 29, wherein  $t_4 < t_5 < t_6 < t_7 < t_8 < t_9$ .

31. The magnetoelectronics information device of Claim 29, wherein said ninth field magnitude is approximately zero.

32. The magnetoelectronics information device of Claim 22, wherein said magnetoelectronics information device is an MRAM element.

33. The magnetoelectronics information device of Claim 22, wherein said third field magnitude is less than about seventy-five percent (75%) of the first field magnitude and greater than about twenty five percent (25%) of the first field magnitude.



34. The magnetoelectronics information device of Claim 22, wherein said third field magnitude is about fifty percent (50%) of the first field magnitude.

35. A MRAM element, comprising:

a free magnetic region comprising a first ferromagnetic layer, a second ferromagnetic layer and a non-magnetic layer interposed between said first ferromagnetic layer and said second ferromagnetic layer;

a pinned magnetic region magnetically coupled to said free magnetic region, said pinned magnetic region comprising a third ferromagnetic layer and an anti-ferromagnetic layer; and

a tunneling barrier interposed between said free magnetic region and said pinned magnetic region,

wherein a magnetic moment of said free magnetic region is unbalanced and magnetic moments of said free magnetic region and said pinned magnetic region that are adjacent to said tunneling barrier are oriented to provide a first magnetization state when:

a first magnetic field with a first field magnitude is produced in proximity to the MRAM element at a first time ( $t_1$ );

a second magnetic field with a second field magnitude is produced in proximity to the MRAM element at a second time ( $t_2$ );

said first magnetic field is adjusted to provide a third field magnitude that is less than said first field magnitude and greater than zero at a third time ( $t_3$ ); and

said second magnetic field is adjusted to provide a fourth field magnitude that is less than said second field magnitude at a fourth time ( $t_4$ ).